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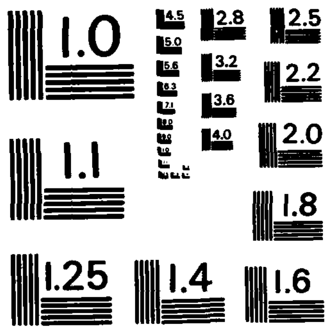

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Instruction Mode and Instruction Intrusiveness in Dynamic Skill Training

Allen Munro
James A. Cody
Douglas M. Towne

August 1982

Behavioral Technology Laboratories
Department of Psychology
University of Southern California

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Unlike computer based instruction of knowledge systems, instructional feedback for dynamic skill training has been found to be most effective when the student chooses when and if feedback is to be received (Munro, Fehling, Blaise, & Towne, 1981). Because students in dynamic skill training are often heavily loaded with processing demands, instructional feedback must be postponed until students have sufficient free resources to process it. The present study attempts to replicate these findings using a simpler task. The second factor in the present study is the effectiveness of computer generated voice output in instruction and simulation in dynamic skill

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) training. These hypotheses were tested in an experiment in computer based instruction. Both the intrusiveness and delivery mode (text-voice) factors had statistically significant effects on student errors. The group which performed the best received feedback in a textual mode and had control over when and if they were to receive feedback. The second best group received feedback in a computer voice mode and had control over when and if they were to receive feedback. The third best group received immediate feedback to errors and feedback that was in a textual mode. The group with the poorest performance received immediate feedback to errors and feedback that was in a computer voice mode. The results suggest (1) that instuction in dynamic skill should be non-intrusive, and (2) that current inexpensive voice systhesis technology is not appropriate for dynamic skill training.

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ABSTRACT

Unlike computer based instruction of knowledge systems, instructional feedback for dynamic skill training has been found to be most effective when the student chooses when and if feedback is to be received (Munro, Fehling, Blaise, & Towne, 1981). Because students in dynamic skill training are often heavily loaded with processing demands, instructional feedback must be postponed until students have sufficient free resources to process it. The present study attempts to replicate these findings using a simpler task. The second factor in the present study is the effectiveness of computer generated voice output in instruction and simulation in dynamic skill training. These hypotheses were tested in an experiment in computer based instruction. Both the intrusiveness and delivery mode (text-voice) factors had statistically significant effects on student errors. The group which performed the best received feedback in a textual mode and had control over when and if they were to receive feedback. The second best group received feedback in a computer voice mode and had control over when and if they were to receive feedback. The third best group received immediate feedback to errors and feedback that was in a textual mode. The group with the poorest performance received immediate feedback to errors and feedback that was in a computer voice mode. The results suggest (1) that instruction in dynamic skill should be non-intrusive, and (2) that current inexpensive voice synthesis technology is not appropriate for dynamic skill training.

ACKNOWLEDGEMENTS

The research work described in this report was performed under Office of Naval Research Contract N00014-80-C-0164. We thank Henry Halff and Marshal Farr for support and advice. Our understanding of the special issues associated with dynamic skill training was also influenced by discussions with Michael Grady and Robin Halley of Logicon, and with Robert Breaux of the Navy Training Equipment Center.

The Pre-AIC training program described in the text is based on an earlier version developed by Michael Fehling, who also contributed to the research plan that led to this experiment.

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INTRODUCTION

Dynamic skill training presents problems and opportunities for computer based instruction (CBI) that are not present in knowledge system training. One such issue is how instruction given in response to student actions can be presented most effectively. In conventional CBI, such instructions are typically presented immediately after the student response that evokes them. In dynamic skill training, immediate presentation of instructions is termed intrusive. Because students' processing resources are more likely to be heavily loaded at the time of the presentation of the instruction, both the simulation practice task and student attention to the instruction are likely to suffer.

Previous research (Munro, Fehling, Blaise, & Towne, 1981) has shown that students who can determine if and when they will receive instructional feedback messages -- termed non-intrusive instruction -- make fewer errors in practice than students who receive intrusive feedback instruction. One of the purposes of the experiment reported here is to discover whether this effect holds in a less demanding task than that used in the previous study. A simpler version of the experimental task used in the previous study was developed. This task retains the essential structure of the Air Intercept Controller task, while imposing fewer requirements.

The Air Intercept Controller (AIC) task requires the student AIC to use a simulated tracking computer station to monitor and track controlled and enemy aircraft, to compute recommended headings for the controlled aircraft, and to direct the controlled aircraft to intercept and destroy the enemy aircraft. The student station includes two display screens, one representing a radar screen and the other the display console of the tracking computer. Student input is by means of a joystick and 11 specially labeled keys on the display console. The task requires close monitoring and expeditious responses to certain events, such as the appearance of a new blip on the simulated radar screen. In addition, the students must periodically perform certain tasks, such as checking the fuel status of the controlled aircraft.

A new issue of concern in the present study was the consequences of computer generated voice output in simulation and instruction in dynamic skill training. A crucial concern was whether currently available low cost voice output devices could play a useful role in dynamic skill simulation training. Many dynamic skill tasks require the use of voice. A natural approach to computer based training of these skills is to make use of computer generated voice. The experiment is designed to compare the use of voice with the use of displayed text for simulation and instruction in the AIC dynamic skill.

Two very distinguishable computer-generated voice output devices were used in the voice conditions of the practice training. A device employing a pre-recorded digital representation of actual human speech was used to simulate the responses of the pilots of controlled aircraft. A text-to-speech synthesis device was used to deliver the same instructional messages sent to the text group students. The speech quality of this device was much less natural sounding than that from the device simulating the pilots' voices.

The results expected from this experiment were, first, that the phenomenon of performance decrements due to intrusion would be replicated. This result was expected to obtain despite the less strenuous task requirements of the revised AIC task. Second, it was expected that the voice conditions would be superior to the text version. The arguments for this expected result were that most students are likely to be better at listening than at reading and that hearing the instructional messages would free the students' visual attention from the message area on the command console, allowing them to to direct it to the task-oriented areas of the console screen and to the radar screen. It was expected that presentation mode (voice vs text) and intrusiveness of instruction would not interact.

The Experiment

Method

Subjects. Sixty-five students participated in the experiment. Twenty-two of the subjects participated in the experiment to fulfill an introductory psychology course requirement. The remaining forty-three subjects were paid volunteers who responded to posted notices or campus paper advertisments at the University of Southern California. Paid subjects received $8.00 for their participation in the experiment. Of the sixty-five that participated in the experiment, sixty completed the experimental training task. Two of the non-paid students chose to discontinue the training task. Poor performance of two others required that they be dropped from the experiment. A temporary equipment maladjustment caused one subject to be dropped.

Procedure. Subjects were run individually in the experient. Completion of the training session required from one hour and forty-five minutes to two hours and forty minutes. All subjects first viewed a six minute videotaped explanation and demonstration of the Air Intercept Controller task. Then they were instructed in the functions of each of the control devices used in the simulated task-- eleven specially labeled keyboard keys and a joystick--by a computer-based-training program called PREAIC. The PREAIC program consisted of a series of text presentations describing the task in greater detail than had been presented in the videotaped introduction. It also presented simulation segments with which the student was required to interact by using the control keys and joystick.

After completing the Pre-AIC computer-based intruction program, all students then viewed the same videotaped sequence which review the special keys used in the simulation, and required them to depress each key as it was reviewed. At this point the treatment of students in the two groups diverged. Each group viewed a videotape segment describing the way in which instructional feedback would be presented to that group and how they should respond. This segment lasted about one minute. Next subjects either heard or viewed each feedback message to familiarize them with the advisories. For the last part of the introduction subjects viewed a videotape of how to perform during a practice problem for their particular experimental condition. Total time spent on the introduction varied from thirty minutes to about forty-five minutes. Students were then given practice in the Air Intercept Controller task, using a simulator trainer program called AIC. The AIC progrm presented a series of 20 problems to the student, organized in three banks of five, ten, and five problems. Difficulty was held roughly constant within each bank, but increased with the progression of problem banks. Students in all four conditions received the same problems, and the training program was the same for students in the four groups in every respect except intsructional feedback.

<u>Instructional Feedback Treatments.</u> The AIC program continually monitored student performance for a variety of errors. Examples include inacurrately positioning a symbol on the simulated radar screen, or failing to get a fuel status update from the pilots of the simulated aircraft within the required time. The Appendix contains a complete list of these errors. For all feedback conditions, when the AIC program detected an error, a warning tone sounded and the word "Advisory" appeared in an area of the computer console display reserved for instructional messages.

At this point, those students in the intrusive text feedback group were presented with a one-line to four-line instructional message related to the error just detected. While the message was displayed, the simulation was *frozen*. The radar screen did not change, and all the normally active keys of the computer console were dead. Only one key, the "Accept message" key, was active until all feedback messages were seen by the student. After the last currently active message was seen, the word "Advisory" was erased from the screen along with the last message. In the intrusive voiced feedback group subjects instead heard the message via headphones while the simulation was frozen. Subjects were required to depress the "Accept message" key until all advisory messages had been heard. Only then was the word "Advisory" erased and the simulation continued.

The students in the non-intrusive text feedback group were not immediately presented with the instructional message after the system sounded the error tone and displayed "Advisory" in the reserved area. Unlike the students in the intrusive conditions, students in the non-intrusive text feedback group were able to choose the time of the appearance of the error messages by depressing a special "Help" key. Depressing this key caused the error message to appear and the simulation to freeze until the student pressed the "Accept message" key. If more than one error had been detected by the system before the feedback message was requested, then the most recent error message was presented to the subject. In each case, depressing the "Accept message" key caused the error message to be erased and the simulation to resume. When all the pending feedback messages were presented, the word "Advisory" was removed. If, at the end of a problem, the student had not viewed messages for all the errors detected by the system, then the student was given the option of seeing those messages before begining the next problem.

As with the non-intrusive text group, subjects in the non-intrusive voiced group were able to choose the time of their hearing the error messages by depressing the special "Help" key. By depressing this key, subjects were able to hear the error message while the simulation was frozen. Simulation resumed when the subject depressed the "Accept message" key. Only when all the messages had been heard did the word "Advisory" erase from the screen. As with the preceeding group, if, at the end of the problem, the student had not heard all the messages for the errors detected by the system, the subject was given the option of hearing those messages before beginning the next problem.

In summary, students in the intrusive feedback groups were presented with an error message for each detected new error at the time that the AIC program recognized the error. Subects in the intrusive text group read the error message and subjects in the intrusive voiced group heard the message. Students in the non-intrusive feedback groups had the option of determining when and whether they would receive the error messages. Subjects in the non-intrusive text group read the messages at their discretion while subjects in the non-intrusive voiced feedback group heard the messages when they wanted to.

Data collection. The AIC simulation training program preserved an exhaustive record of each student's interactions with the program. These data sets were later processed by data extraction programs to produce records of errors, time on problems, and other variables of interest.

Results

Errors. Number of errors was used as one measure of learning. Table 1 presents an analysis of variance of the error data. The mean number of errors for the students in the intrusive text group was 97.9, and for the intrusive voiced group, the mean number of errors was 143.8. The mean number of errors for the students in the non-intrusive text group was 76.6, and for the non-intrusive voiced group, the mean number of errors was 89.1. These differences were highly significant, suggesting that students in the non-intrusive groups learned more than the intrusive groups and also that subjects in the text groups performed better than subjects in the voiced groups.

Time per problem. The total time spent on each problem by each student was recorded. Table 2 presents the analysis of the total time on problem data, where time is expressed in tenths of seconds. Intrusive text group students spent a mean of 218.1 seconds per problem, and the intrusive voiced group students took 241.3 seconds. Non-intrusive text subjects spent an average of 215.0 seconds per problem and non-intrusive voiced subjects took 230.2 seconds. The difference was not significant for either factor. Actual time spent on each problem was also recorded for each subject. Actual time is the total time spent on a problem minus the time the subject spent attending to feedback. Table 3 presents the analysis of the actual time on problem data, where time is expressed in tenths of seconds. Intrusive text group students spent a mean of 201.0 seconds per problem, and the intrusive voiced students took 213.6 seconds. Non-intrusive text subjects spent 202.5 seconds per problem and non-intrusive voiced subjects took 206.8 seconds. This difference was not significant for either factor.

Crucial and non-crucial errors. Student errors are classified by the AIC program into twenty-eight types. Of these, eighteen may be termed "crucial" errors, in that they are likely to materially affect the student's chances of "winning" an exercise by shooting down the enemy aircraft. The other ten types of errors are non-crucial in that they reflect errors of form that will not immediately decrease the chances of winning the problem. Table 4 presents the analysis of total crucial errors for all twenty problems. It shows that there is no significant difference between any of the conditions. The intrusive text group made an average of 2.74 crucial errors per problem, while the intusive voiced group made 2.91. The non-intrusive text group made an average of 2.66 crucial errors per problem, while the non-intrusive voiced group made 2.58.

The mean number of non-crucial errors per problem for the intrusive text group was 2.12. The intrusive voiced group made a mean of 4.24 non-crucial errors per problem. The mean number of non-crucial errors per problem for the non-intrusive text group was 1.16, while the non-intrusive voiced group made 1.85 non-crucial errors per problem. Table 5 shows that these results are significant. This suggests that, even though overloaded by the intrusive instructional messages, the intrusive groups were still able to decide which performance factors to attend to. They chose to permit greater deterioration of their non-crucial performance rather than their crucial performance. It also suggests that voiced feedback is detrimental to performance, particularly when it is intrusive. Subjects that receive the spoken messages are required to attend to the error message for a much longer time and this requires more processing than text subjects who simply glance at the written error message.

Joystick errors. In an attempt to determine what kind of performance is affected by the intrusiveness and mode of instructional feedback, a separate analysis of joystick errors was performed. Most of the AIC task requires the fusion of skills of planning, time or distance estimation, and decision making, as well as some motor coordination. This is the task of using the joystick and keyboard to "hook" a symbol on a simulated radar screen blip. Table 6 shows that there was no significant difference in the total number of joystick errors made by subjects in the four experimental conditions over the course of the twenty practice problems. This implies that the deleterious effects of intrusive and/or voiced feedback may not equally degrade all types of skills. The motor skill of using the joystick appears not to be harmed by the processing loads imposed by intrusive or voiced feedback.

Discussion

The error results support the hypothesis that the processing demands of dynamic skill simulation training require non-intrusive rather than intrusive feedback. Students receiving intrusive feedback made significantly more errors than did those who received non-intrusive instruction. Analysis of crucial and non-crucial errors reveals that there is a significant difference in number of errors made only for non-crucial errors. Apparently because the task is easier than that used in the previous experiment (Munro et al, 1981), intrusive group students were able to perform the crucial sub-tasks as well as the non-intrusive group students. Only on the non-crucial subtasks did the intrusive group students make significantly more errors than did the non-intrusive group students.

The separate analysis of joystick errors supports the view that motor skills may not be as affected by the information processing overload imposed by intrusive instruction as are memory and decision-making processes.

Further research is called for to determine whether errors in training are indicative of the level of final performance after more extensive training. If students in the intrusive instruction group make more errors in the first few hours of training, does this mean that they will necessarily make more errors after more exhaustive training? Will they reach a criterion level of performance more rapidly? More exhaustive longitudinal studies are called for to answer these questions. The present study suggests that if an objective is to minimize errors during dynamic skill training, then non-intrusive instruction is preferable to intrusive instruction.

The error results did not support the hypothesis that voice instruction in dynamic skill training is more effective than text instruction. To the contrary, voice instruction resulted in significantly more errors than did text instruction. Two plausible explanations can be offered for this result. The first is that it takes longer to listen to a spoken message than to read the same message, at least for practiced readers. Therefore, voice instruction took attention away from the ongoing task for longer periods of time, resulting in more short-term memory decay than for those students who read the same messages. The second explanation is that the quality of the voice instruction was not very good, so that listening to the instructions required significantly more processing resources than reading the same instructions.

The disappointing performance of voice instruction in this experiment does not necessarily mean that voice cannot be used effectively in dynamic skill training. It does mean that the low-quality voice output used in this experiment may not be appropriate for dynamic skill training. It remains to be determined whether a more intelligible voice output device would cause performance decrements.

REFERENCES

Munro, A., Fehling, M. R., Blaise, P., Towne, D. M. Intrusive and Intrusive Instruction in Dynamic Skill Training. (Technical Report No. ONR-97). Los Angeles: Behavioral Technology Laboratories, University of Southern California, 1981.

APPENDIX: Crucial and Non-Crucial Errors

CRUCIAL ERRORS

1. Hooking symbol off the blip. This error occurs when the student depresses one of the symbol keys (e.g., B1) when the cursor is not positioned directly over the blip. It is a crucial error because subsequent interception computations will be based on the position and heading of the symbol rather than the blip.

2. Failing to hook a CAP for more than 60 seconds after it appears. This is the error of not identifying the new blip for more than a minute after it appears. No intercept computations can be made for that CAP until it has been hooked.

3. Failing to rehook the CAP for more than 30 seconds after first hooking it. This error occurs when the student identified a CAP but failed to label it a second time. The tracking computer has no speed or direction for the CAP that was not rehooked.

4. Failing to hook a Bogey for more than 24 seconds after it appears. This error is similar to 2, above.

5. Failing to rehook a Bogey for more than 18 seconds after first hooking it. This error is similar to 3, above.

6. Failing to rehook a Bogey for more than 36 secods after a heading jink. This error occurs when the Bogey changes direction from the currently plotted path and is not rehooked (relabeled). The tracking computer will use the old, incorrect course for any computations of intercept, etc.

7. Failing to rehook a Bogey for more than 36 seconds after a speed jink. This error occurs when the student fails to rehook the Bogey blip after it speeds up or slows down. After a speed jink, the Bogey's radar blip does not match the position of the Bogey's label on the screen. As with error 6, subsequent computations based on the Bogey's position and speed will be incorrect.

8. Failing to rehook a CAP for more than 36 seconds after it does a heading jink. As in error 6, a change in direction must be entered into the tracking computer or subsequent computations will be incorrect.

9. Failing to compute an attack heading within 18 seconds of rehooking a Bogey. After a Bogey has been hooked and rehooked, the tracking computer has a representation of its speed and direction. If the student fails to compute an intercept/attack heading quickly, the Bogey may escape from the nearest CAP.

10. Failing to compute an attack heading within 18 seconds of a jink by a Bogey under attack. A Bogey being attacked must not only be

rehooked quickly after it jinks, but a new attack heading must be computed, as well.

11. Failing to rehook a CAP for more than 36 seconds after a CAP makes a speed jink. As with error 7, subsequent computations depend on accurate tracking of blips.

12. Failing to send a new attack heading to a CAP for more than 18 seconds after it spashes a bogey. If more than one Bogey is to be attacked by a CAP, then a new attack heading must be sent to the CAP to direct it to intercept the next Bogey after it destroys the prior assigned Bogey.

13. Sending an incorrect attack heading. This error occurs when a student misreads or mistypes the previously calculated attack heading.

14. Failing to send an attack heading for more than 12 seconds after computing it. The computed attack heading should be sent quickly to the CAP if the intercept is to be effected.

15. Failing to fire while in firing range. The CAP's weapons are effective only at close range. If a CAP moves into firing range of its assigned Bogey and then moves out of that range again without firing, then the student has made this error.

16. Firing when not on attack heading. No attack heading has been sent to the CAP, so the fired missle is wasted.

17. Failing to fire for more than 12 seconds after entering firing range. Waiting this long in firing range is likely to result in being shot down by the enemy.

18. Firing when not on correct attack heading. If a CAP fires when it is not on a correct attack heading for its Bogey, then a missle has been wasted.

NON-CRUCIAL ERRORS

1. Failing to rehook a CAP for more than 36 seconds after it turns to attack. This error is non-crucial because the CAP is on the correct attack heading and can successfully down the Bogey.

2. Firing when out of firing range. The student fires a missle before the CAP is close enough for its weapon to be effective.

3. Firing when out of missles. This is non-crucial because it does not affect the number of Bogeys shot down.

4. Failing to get a fuel and weapons update for more than 60 seconds after rehooking a CAP. The update informs the student how many

pounds of fuel and how many weapons each active CAP has. This information does not contribute to the core task of destroying the Bogeys.

5. Failing to get a fuel and weapons update for more than 60 seconds after the previous such update.

Total errors, means. By instructional treatment group.

	Intrusive Feedback Group	Non-intrusive Feedback Group
Text	97.9	76.6
Voice	143.8	89.1

2-WAY ANOVA

Source of Variation	DF	F	Significance
Intrusion	1	12.40	.001
Delivery mode	1	7.32	.01
Intrusion x Mode	1	2.39	n.s.
Residual	56		

Table 1.

Total Errors. Analysis of Variance.

Total crucial errors, means. By instructional treatment group.

	Intrusive Feedback Group	Non-intrusive Feedback Group
Text	54.93	53.27
Voice	58.30	51.70

2-WAY ANOVA

Source of Variation	DF	F	Significance
Intrusion	1	0.76	n.s.
Delivery mode	1	0.04	n.s.
Intrusion x Mode	1	0.27	n.s.
Residual	56		

Table 2.

Crucial Errors. Analysis of Variance.

Total non-crucial errors, means. By instructional group.

	Intrusive Feedback Group	Non-intrusive Feedback Group
Text	42.5	23.33
Voice	84.9	37.10

2-WAY ANOVA

Source of Variation	DF	F	Significance
Intrusion	1	21.68	.001
Delivery mode	1	15.18	.001
Intrusion x Mode	1	3.95	n.s.
Residual	56		

Table 3.

Non-crucial Errors. Analysis of Variance.

Total time on problems (seconds), means. By instructional treatment group.

	Intrusive Feedback Group	Non-intrusive Feedback Group
Text	4362.2	4300.0
Voice	4826.0	4605.4

2-WAY ANOVA

Source of Variation	DF	F	Significance
Intrusion	1	0.91	n.s.
Delivery mode	1	6.72	n.s.*
Intrusion x Mode	1	0.29	n.s.
Residual	56		

*Approaches significance, <.02

Table 4.

Total Time on Problem. Analysis of Variance.

Actual time on problems (seconds), not including feedback, means.
By instructional treatment group.

	Intrusive Feedback Group	Non-intrusive Feedback Group
Text	4020.8	4050.2
Voice	4272.6	4137.6

2-WAY ANOVA

Source of Variation	DF	F	Significance
Intrusion	1	0.22	n.s.
Delivery mode	1	2.30	n.s.
Intrusion x Mode	1	0.54	n.s.
Residual	56		

Table 5.

Actual Time on Problems. Analysis of Variance.

Joystick errors, means. By instructional treatment group.

	Intrusive Feedback Group	Non-intrusive Feedback Group
Text	19.33	19.87
Voice	22.50	17.60

2-WAY ANOVA

Source of Variation	DF	F	Significant
Intrusion	1	1.57	n.s.
Delivery mode	1	0.07	n.s.
Intrusion x Mode	1	2.42	n.s.
Residual	56		

Table 6.

Joystick Errors. Analysis of Variance.

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